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ABSTRACT

An innovative flight training program, its development, and initial administration are described. The program involves use of a commercially available training device in a twin-engine transition and instrument training course. Principal features of the training include redefinition of the flight instructor's role, and incentive award system, proficiency-based advancement, full mission training in the device, continuity of training between the device and aircraft, and use of maneuver performance records to control trainee progress. During initial administration of the program by the Army, training flight hour requirements were reduced approximately 40%. The innovat process as it was applied in the development of the described train ng program also is discussed. (Author)

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HumRRO

An Innovative Instrument Flight Training Program

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The Human Resources Research Organization (HumRRO) is a nonprofit corporation established in 1969 to conduct research in the field of training and education. It is a continuation of The George Washington University Human Resources Research Office. HumRRO's general purpose is to improve human performance, particularly in organizational settings, through behavioral and social science research, development, and consultation. HumRRO's mission in work performed under contract with the Department of the Army is to conduct research in the fields of training, motivation and leadership.

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16. Abstracts

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Prefatory Note

This paper was presented at the Fourth International Simulation and Training Conference of the Society of Automotive Engineers, in Atlanta, Georgia, in May 1971. The research reported was performed at the Human Resources Research Organization Division No. 6 (Aviation), Fort Rucker, Alabama, under Work Unit SYNTRAIN, Modernization of Synthetic Training in Army Aviation. Dr. Caro is a Senior Staff Scientist with the HumRRO Division.

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An Innovative Instrument Flight Training Program

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SOCIETY OF AUTOMOTIVE ENGINEERS

Fourth International
Simulation and Training Conference
Atlanta, Ga.
May 13, 1971

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An Innovative Instrument Flight Training Program

Paul W. Caro
Human Resources Research Organization

HAVING AGREED TO PREPARE a paper about an innovative instrument flight training program the writer was forced to ponder the question, "What is an innovation?"* Other writers pondering this question, particularly writers in the field of education where "innovation" has become a key word of sorts, often have evaded a definition of the term but have talked about changes in the way things are done. These changes have included modifications to existing practices, as well as the addition of something new or the complete elimination of a pre-existing practice. Some writers have attempted to use the term innovation only when talking about novel approaches to a problem, but others have been more liberal in its use. In each case, however, innovation has been equated with a better, more efficient, or cost-effective way of doing something.

BACKGROUND

Often changes called innovations are attributed to innovative people, while changes not bearing that label are attributed to factors such as advancing technology, modernization, or simply the Zeitgeist. Was the substitution of digital computers for analog computers in aircraft simulation an innovation wrought by an imaginative innovator, for example, or would you characterize it as a technological advancement that was inevitable? How would you characterize the introduction of an aircraft procedures trainer into a training program that already uses sophisticated training equipment? Would you characterize it differently if the procedures trainer were made of a new medium, such as plastic or paper, and each trainee were given his own device for home study? Would you consider the use of programed instruction in yet another training program to be an illustration of innovation in training? How would you label an administrative realignment of duties among members of an instructional staff?

Each of these changes has occurred recently in Army instrument training, and, if you wish, they may be labeled innovations. Those who equate the term to technological breakthrough or large magnitude changes that result from the creativity or insight of a highly imaginative innovator, will be disappointed with this paper. There have been no real breakthroughs coming out of our work on instrument training. Changes have occurred in the way training is conducted, in the design of training equipment, and in the alignment of instructional responsibilities, but these changes may be considered novel only with respect to a specific training application. Con-

*The ideas expressed in this paper are based on research conducted at HumRRO Division No. 6 (Aviation), Fort Rucker, Ala., under Department of the Army contract; the contents of this paper do not necessarily reflect official opinions or policies of the Department of the Army.

ABSTRACT

An innovative flight training program, its development, and initial adminstration are described. The program involves use of a commercially available training device in a twin-engine transition and instrument training course. Principal features of the training include redefinition of the flight instructor's role, an incentive award system, proficiency-based advancement, mission training in the device, continuity of training between the device and aircraft, and use of maneuver performance records to control trainee progress. During initial administration of the program by the Army, training flight hour requirements were reduced approximately 40%. The innovative process as it was applied in the development of the described training program also is discussed.

sidered individually, the changes may be characterized as practices or concepts borrowed from other training programs or equipment or adapted from other applications. Individually, they are consistent with the hypothesis that there is nothing new under the sun.

There has been an important factor in Army aviation which has allowed major improvements in training practices and equipment to take place. The factor might be described as a Zeitgeist, and it is most visible in the efforts toward transition to a volunteer Army. It is an atmosphere which permitted my organization to challenge existing training practices and equipment characteristics to determine whether there might be alternate and better ways of accomplishing the same goals. No training practice or training equipment feature has been exempted from scrutiny simply because it was traditional or because existing Army or Aviation School policy required it. This atmosphere of permissive investigation is not greatly unlike that which permitted the airline industry to seek new training approaches, rather than to adhere rigidly to established FAA training policies.

Some of the more significant changes which have occurred recently in Army pilot training relate to equipment design. They have been described elsewhere (1, 2).* In this paper I shall discuss a recent instance in which changes have been made in instrument training practices. It involves the development of a training program in an undergraduate level, fixed wing, twin-engine transition and instrument training course.

Taken as a whole, the new training program constitutes a comprehensive set of changes from previous practices of comparable military and civilian flight training programs. The objective of these changes has been to reduce training costs while maintaining a previously established level of student proficiency. In the description that follows, I shall not be concerned with whether any program element is a local innovation or an adaptation from another aviation or nonaviation training program. I also shall make no claims regarding the contribution of any single change to the results obtained. The improvement in training efficiency resulting from the training program described is the result of the total program. The relative merit of individual changes is a matter for further study.

APPROACH

The approach taken to the development of the new training program was to apply the expert judgment of the HumRRO research staff. The procedures involved were developmental rather than experimental. Some of the concepts and training rationale included in the program were taken directly from other pilot training programs (including some at the Army Aviation School), while others evolved from concepts found in the training technology and human learning literature. During the evolutionary process, typical trainees were used to evaluate several methods of instruction and of shaping trainee behavior through augmented feedback techniques. Some of these methods and techniques were either dropped from further consideration or were extensively modified before the total program was made available to the Army.

A single guiding principle, cost effectiveness, was used in devising the new training program and each of its elements. For training, cost effectiveness translates to achieving given training requirements with the minimal feasible cost in dollars. Toward this end, a number of considerations of modern training technology were applied in combination. Most notable of these are:

1. Organization of the training program around a functional context, that is, around sets of meaningful, purposeful, mission modules, and teaching training content in the context of the mission-oriented purpose it supports.
2. Individualization of training, that is, adapting the pace and redundancy in training to the rate of learning of each student and advancing a student to the next set of instructional content only after he has demonstrated mastery of an earlier set.
3. Sequencing of instruction, that is, arranging the order of instructional content so that there is assurance students have been taught (and have mastered) prerequisite knowledges and skills before training in a new set is undertaken.
4. Minimizing equipment cost, that is, to the extent that is efficient, substituting training in devices or other less expensive equipment for the much more expensive training conducted in aircraft.
5. Avoiding over-training, that is, assuring that training time is restricted to that needed to bring a trainee to the required level of proficiency and no more.
6. Efficient utilization of personnel resources, that is, each instructor should be optimally qualified for his task, should be provided the tools he may require for efficient use of his time and talents, and should have clearly stated and measurable instructional objectives to attain.

The detailed development of the training program was guided by these principles. In addition, knowledge of numerous aviator and other training studies, of pilot training practices of other organizations, and of the Army's training requirements, and detailed familiarity with resources available was possessed by the staff engaged in the program development.

It would not be fruitful to attempt to describe the detailed evolution of each individual feature of the training program which resulted from this developmental process. A basis for each of these features, either in the training-related literature or in the practices of other training organizations, will be recognized by the reader. Instead, the following sections of this paper will describe the principal features of the program, its initial use by the Army, and its training efficiency when compared to the program it was developed to replace.

A NEW INSTRUMENT TRAINING PROGRAM

In 1968, HumRRO conducted a study of the Aviation School's fixed wing training device requirements (3). One result of that study was the procurement by the Army of a twin-

*Numbers in parentheses designate References at end of pa-

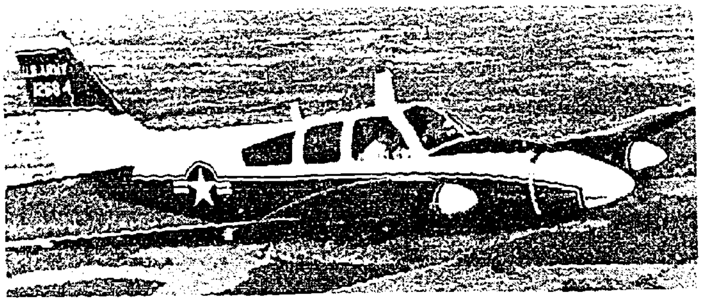

Fig. 1 - T-42 aircraft

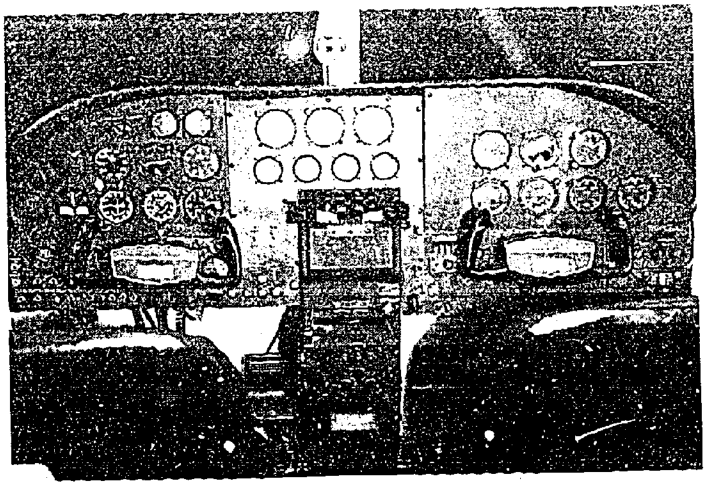

Fig. 2 - GAT-2 instrument training device cockpit

engine instrument procedures trainer, the GAT-2*, for use in undergraduate pilot training. The objectives of that particular phase of undergraduate training are to transition student pilots to a light, twin-engine aircraft, the T-42 (Fig. 1), and to provide instrument flight training to those students. Students entering the phase have approximately 110 hr of flight training in a single-engine T-41 aircraft. The GAT-2 was procured by the Army to replace an obsolete device previously used in the course. Rather than using the training program developed years ago for the obsolete device, HumRRO undertook the development of a new twin-engine transition and instrument training program which would be more suitable for use with the new device.

Introduction of the new device into undergraduate flight training was itself a significant change. The device, shown in Figs. 2 and 3, is configured like a light twin-engine aircraft, complete with dual controls. An instructor station is located inside the cockpit behind the pilot and copilot positions. Although it is properly considered to be an instrument procedures trainer, rather than an aircraft simulator, its configuration is much more like that of the Army's instrument training aircraft than has been the case with previous instrument training devices. The similarity of the device to the aircraft was further enhanced by the device manufacturer who made minor configuration changes in their production model, so that its control arrangement would more closely approximate the T-42. While still not simulating the aircraft, the device looks and "flies" about like the T-42. It would be possible to train a student to fly the device much the same way that students are taught to fly the aircraft itself, that is, with an instructor seated beside him.

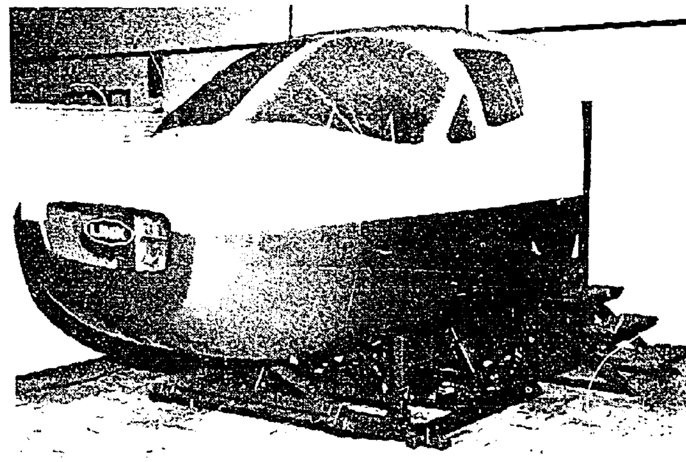

Fig. 3 - Exterior view of GAT-2 instrument training device

PROGRAM OBJECTIVES AND LIMITATIONS - The pilot performance objectives of its twin-engine transition and instrument flight training have been stated clearly by the United States Army Aviation School in various documents related to the course. These objectives, which require course graduates to operate the twin-engine T-42 aircraft in accordance with FAA and Army visual and instrument flight regulations, were adopted without change as the objectives for the new training program. Graduates from the new program are indistinguishable, so far as flight performance is concerned, from graduates of the existing program.

The intent of the new program, therefore, is to produce pilot graduates who meet these performance objectives at less overall costs than are being incurred in the existing program. Costs can be reduced in flight training programs principally through reductions in aircraft operating time. Thus, a reduction in the number of aircraft flight hours required to attain the stated performance objectives is the principal means through which reduced costs are to be realized. Consideration was given during development of the new program, as is indicated above, to the relative costs of all its features to assure that savings resulting from reduced flight-hour costs were not offset by costs incurred as a result of the introduction of other training practices. To reduce the risk of introducing undesired costs elsewhere, the new course makes use of only those resources already available at the Aviation School (excluding the new device itself), and requires the same calendar time for its conduct as does the existing program.

*The GAT-2, manufactured by Link Div. of the Singer Co., Silver Spring, Md, is identified in this paper for purposes of research documentation, and its use or citation does not constitue an official endorsement or approval by either the Human ources Research Organization or the Department of the ıy.

PROGRAM SCHEDULE - The new program is divided into two segments. During the first, all flight training which can be adapted to the new device is conducted in it. The aircraft is not used in any way. Additionally, all required academic training is accomplished during the same period. The device and academic training are accomplished on a proficiency basis. Approximately three weeks of five working days each are devoted to device and academic training. Training in the device, including associated briefing and administrative time, occupies approximately 4 hr each workday, and academic training occupies about an additional 3 hr/day. During the last few periods of academic training, a paper procedures trainer for the T-42 aircraft is used to aid trainees in their transition from the new device to the training aircraft. No other training activities are scheduled during these first three weeks.

All scheduled training during the remaining scheduled time, that is, the next three weeks, is conducted in the aircraft, although the new device may be used for training at the option of the flight instructor. The aircraft training concentrates upon two activities:

1. The conduct of training that is required, but that cannot be conducted in the simulated IFR environment of the new device, for example, landings.
2. The refinement of skills previously trained in the device.

When, in the opinion of the respective flight instructors, the trainee is prepared for the checkride which the Aviation School requires of trainees in the existing program, those checkrides are adminstered by a check pilot. When the trainee successfully passes the end-of-training checkride, no further twin-engine transition and instrument flight training is administered to him. In the event this occurs prior to the scheduled completion of the course, he is excused from further nonessential military duties until the next phase of his training is scheduled to begin.

The new program is designed for administration on an individual basis with advancement based solely upon student proficiency, that is, the criteria of training are based upon attained trainee performance. There is no requirement in the new program that any minimum amount of flight training, as measured by hours spent in the device or hours logged in an aircraft, be administered to each trainee. To facilitate personnel and equipment scheduling, however, the hours estimated to be required for each type of training (Table 1) are provided. These numbers do not represent hour requirements, however. Course completion is based solely upon attained proficiency rather than hours of exposure to a training environment. For comparison purposes, the hours scheduled in the existing program are also presented in Table 1.

Table 1 - Approximate Number of Training Hours Required

	Aircraft Time, hr	Device Time, hr	Classroom Time, hr
New program	35	25	45
Existing program	60	21	90

PRINCIPAL PROGRAM FEATURES - The new training program has been made available to the Aviation School. The present description of it is significantly less detailed than the documentation provided the Aviation School, since a fully detailed exposition of the program would be of little interest to personnel not involved in comparable training. The intent of the present paper is to convey to the reader primarily the gen- ire of the new program, rather than the details neces- its administration. Thus, attention here is concentrated upon those principal features which distinguish it from the existing twin-engine transition and instrument training program of the Aviation School and comparable programs of other training organizations.

Administrative - Some of the distinguishing features of the new program are administrative in nature. The most significant of these is the concentration of responsibility for all of a student's training in the hands of his flight instructor. Traditionally, in undergraduate training programs, the flight instructor has been responsible only for that portion of a student's training which takes place in the aircraft, while a device instructor is responsible for device training, and several classroom instructors share responsibility for other portions of training. Presumably, this divided responsibility is compensated by a superior management effort or higher instructing skills. In practice, however, flight instructors often complain that device instructors are teaching the wrong thing or that classroom instructors do not present necessary information until some time after it is required in the air.

In the new program, by contrast, the flight instructor is *the* instructor. He conducts or oversees all training received by his students. The resources he needs—an aircraft, a training device, programed textbooks, and personnel to assist him when required—are made available.

During the initial three weeks of the course, the flight instructor conducts carefully structured training in the device. During this period, he also assigns to his trainees programed texts* covering all of the information that they will require, and he does this on a schedule which assures that they have covered the material prior to needing it in the trainer. An assistant, who is familiar with the programed texts, is available during this period to help the students should they have difficulty with the material, but the effort of the assistant is super vised directly by the flight instructor. It should be noted that much of the training provided by the flight instructor in the device could not be achieved by a nonrated device operator.

After each trainee has completed all the required programed texts and has developed all the specified skills in the device, the locus of instruction is shifted to the aircraft. This occurs at about the beginning of the fourth week of training. The remaining scheduled training takes place in the aircraft. However, should the instructor feel that additional practice in the device would help the trainee overcome a particular problem, remedial device training may be prescribed.

*Programed textbooks were available from other courses at the Aviation School and contained all the information required to be taught in the new program.

Training in the aircraft is expensive, and the instructor's effort is directed toward minimizing requirements for it. His responsibility, so far as inflight training is concerned, is to prepare his student for the final checkride to be administered by the Army's flight check personnel. It is emphasized to the instructor that building up student flight time is not the goal of the new program; rather, it is the building of flight skills. Therefore, on occasions when the student appears unresponsive during flight instruction—as students occasionally do—the instructor is encouraged to terminate the period. To continue to fly a student under these circumstances only adds expense to an already costly program. Thus, there is no requirement to log any specific amount of aircraft time per student per day.

To encourage the flight instructor to prepare his students in a minimum amount of time, a progress ride identical in content to the end-of-course checkride, is administered at an hour level between 2/3 and 3/4 of the total projected flight time that conduct of the course should take, that is, at about the 25 hr level. Students passing this progress ride will have demonstrated end-of-course proficiency and can be graduated from the phase at that point. One purpose of the progress ride is to discourage flight instructors from holding back a student beyond the time when he could pass a checkride just so that he might attain a higher grade. Such a practice adds unnecessary cost to training.

The primary purpose of the progress ride, however, is diagnostic. It is intended to identify those skills upon which the instructor should concentrate in order to prepare his student, as soon as possible, for the end-of-course checkride. An important part of the checkride, then, must be a provision for detailed feedback to the instructor involved. This feedback is accomplished by having the check pilot debrief the instructor in detail on trainee performance. This debriefing occurs right after the progress ride itself.

Attaining high grades has certain useful motivational value in flight training. Additionally, building up more flight time has motivational value also. It could be expected that a course designed to lower student grades and reduce the amount of flight time he can log might be poorly received. The new program includes an incentive award system designed to overcome these problems. The system is performance oriented rather than schedule oriented. The incentive award system has two elements.

First, a student is awarded a checkride grade by his check pilot as is customary. Added to that checkride grade are a number of points determined by the hour level at which he completes training—the lower the total flight time required to complete training, the greater the number of points awarded. For example, with a scheduled course length of 35 hr, a trainee who passes the course checkride in 30 hr with a checkride grade of 75 would be credited with an additional five points, one point for each hour saved. His adjusted checkride grade would be 80, a grade which would more accurately reflect his ability to develop skill as a pilot.

The second element of the incentive award system is free time. Other HumRRO research has shown that Army trainees attach considerable value to free time, and that it can be used to motivate them. In the program under review here, a trainee who passes the required checkride in less than the allotted eight weeks of the course is given time off from all nonessential military duties for the remainder of the eight weeks. When all trainees assigned to a particular instructor complete the course requirements, then he too is awarded time off as an incentive to him to expedite this training and reduce expensive flight time.

Thus, there are four principal administrative aspects of the new program which distinguish it from traditional practices: the assignment of full responsibility for training to the flight instructor, a diagnostic progress ride at a set point in training, feedback to the instructor pilot, and an incentive award system.

Training - The new device is by no means a T-42 simulator. It is particularly weak with respect to handling qualities, and it is very difficult to trim. Further, the cockpit controls and the instrument panel are notably different from those of the training aircraft. Nevertheless, the similarity between the T-42 and the new device is much greater than with any other pilot training device in the Army inventory. The significance of these similarities is that they permit the device to be treated as an aircraft rather than as an item of training equipment. The simulation provided in the new device is sufficiently complete, so that it is a plausible representative of an unspecified light twin-engine aircraft such as the T-42. A pilot able to fly one such aircraft, presumably, could transition to another with minimum difficulty.

During the first three weeks of student training--the time that training was conducted in the device and programed textbooks were being studied—every procedure and maneuver that could be performed in both the device and the aircraft were performed in the device. These include all aircraft prestart, start, run-up, and shutdown procedures, using checklists prepared to correspond, whenever possible, to the T-42 checklists; IFR missions, from instrument take-off through approaches and missed approaches; and, to a limited extent, training to cope with inflight emergencies. In the case of the latter, for example, a fuel starvation engine failure may be simulated, and the single-engine procedures similar to those required in the aircraft can be practiced.

All this training is performed in the context of crew training. Because of dual instruments and controls, a copilot seat, and a separate jump seat, two trainees always occupied the device. Except during initial training sessions where instructor assistance may be required with aircraft control tasks, a second student, seated in the copilot seat, performs normal copilot duties under instructor supervision. In addition to permitting specialized copilot training when the instructor is not required in the copilot seat, this exposure to the training of a fellow student has been shown in other research (4) to aid pilot trainees, particularly where procedural and communications skills are concerned.

All training in the course is functional with respect to operational requirements. The first training period in the device, for example, is modeled after flight tasks typical of instrument

flights in the training aircraft. It consists of performance of necessary aircraft checks and starting and run-up procedures, an instrument take-off, climb to assigned altitude, compliance with radar steers, and initiation of a VOR approach. Typical training periods consisted of filing an IFR flight plan and executing, in the trainer, the prescribed flight. The widely practiced procedure of practicing "basic airwork" during early training periods is not followed in the new program.

Transition to the aircraft is designed to require minimum disruption in training. As trainees begin to become proficient in the device, they prepare to transition to the T-42. Using a very low cost T-42 paper trainer developed by HumRRO, T-42 checklist procedures are practiced to mastery so that minimum aircraft time is lost due to unfamiliarity with the aircraft itself. As a result, getting into the air during the first aircraft flight period requires no more time than for students who typically have 20-30 hr of experience in the T-42. Transition is further enhanced by the fact that students and instructors are already familiar with each other, that is, the only thing new about the situation is that now the actual aircraft is being used.

The first flight period in the aircraft is largely a repeat of the last flight in the device, using a similar IFR clearance. Since each trainee has demonstrated in the device that he can plan a flight, file a flight plan, and fly the flight within specified tolerances in the device, his task during the first aircraft period is that of doing the same thing in the aircraft. In other words, the portion of the new training program conducted in the aircraft is primarily that of transitioning to the aircraft and polishing skills already acquired in the trainer.

There are, of course, aircraft control skill requirements which cannot be practiced in the device and have to be learned in the aircraft itself. These skills relate to control of the aircraft by external visual reference. A portion of the flight training in the aircraft, therefore, must be devoted to development of these VFR skills.

The VFR training also is conducted in a functional context. The usual practice of scheduling periods of VFR training early in the course in order to "check out" the trainee in the aircraft before instrument training begins is not followed in the new program. Instead, the required VFR training is conducted, as occurs in actual practice, as a part of a practice IFR cross-country flight. For example, at destination, students fly traffic patterns and land the aircraft in accordance with simulated or actual ATC instructions. This is a type of application of the integrated contact-instrument flight training concept studied in previous HumRRO research (4). As with all other training in the new program, the VFR training in the aircraft is accomplished on a proficiency basis. The instructor is required to train to specified performance objectives, and there are no hour or experience requirements involved.

Thus, there are four principal training features of the new training program which distinguish it from the existing course, features which, for the most part, are made feasible by the correspondence between the device and the training aircraft. These are the provision of full mission training in the device, the training of pilot and copilot skills within a crew training context, the conduct of all training within a functional context,

SINGLE ENGINE PROCEDURES
(Cruise)

Student__________ Sheet No. 1

Date	11/2	11/3	11/4		
Power (as required)	X	✓	✓		
Identified dead engine	✓	✓	✓		
Throttle (dead engine) closed	✓	✓	✓		
Prop lever (dead engine) feather	✓	✓	✓		
Gear (as required)	✓	✓	✓		
Flaps (as required)	✓	✓	✓		
Power (as required)	✓	✓	✓		
Trim	✓	✓	✓		
Cowl flaps (as required)	✓	✓	✓		
Fuel quantity switch & selectors (as required)	✓	✓	✓		
Alternator (dead engine) off	✓	✓	✓		
Airspeed 102 kts min.	✓	✓	✓		
Altitude (±100')	X	X	✓		
Direction (±10°)	X	X	✓		
Errors	3	2	0		

Total prior time: 1st trial 15:00 Criteria reached 17:00

Fig. 4 - Example of maneuver performance record

and the continuity of training conducted in the device and in the aircraft.

Other - In addition to administrative and training content features, there were other distinguishing aspects of the new program. One of these, the individualization of instruction through proficiency advancement techniques, already has been identified. All training—device, academic, and flight—is conducted on a proficiency advancement basis in the new course, and there are no requirements that a student receive a stated amount of training of any kind at any time.

Advancement of students from one block of instruction to another is accomplished in an objective manner. Maneuver performance records (MPR) were developed to facilitate this. The MPRs enabled the flight instructor to attend to each parameter of student performance during execution of a maneuver in the device and to record each deviation from the required performance objective. Using the MPRs, the instructor advances trainees from maneuver to maneuver in an objective manner that precludes unnecessary practice beyond required levels of mastery. An example of an MPR is shown in Fig. 4.

The MPR serves another important function as well. It provides detailed descriptions of trainee performance throughout his training in the device. The descriptions are an excellent means of providing knowledge of performance to the trainee, since they can be (and are) reviewed with him following each maneuver he performs. Specific, detailed information is thus available to both the instructor and the student concerning errors in student performance, progress over trials, and the changes in performance yet required before the necessary performance objective is reached.

In this new course, trainees are required to demonstrate appropriate skills in a progressively functional manner. Before any maneuver is performed by a trainee in the device, for example, he is required to describe all relevant aspects of that maneuver in detail to his flight instructor. Before the same maneuver is performed in the aircraft, it must have been performed without error in the device. The MPRs are of considerable value to both the instructor and the student in accomplishing this progressive training.

INITIAL TRAINING PROGRAM USE

The training program described above has a number of features which are unfamiliar to most instructor pilots. For example, it requires that they be familiar with the new device, the use of MPRs, and functional context training. Therefore, before the new program could be made available for use, it was necessary to train flight instructors to use it.

Two Army officers who were qualified to conduct flight instruction in the existing twin-engine transition and instrument training program were designated by the Aviation School to be trained by HumRRO to conduct the new training program.* Upon completion of their training they were to train other Aviation School personnel in the conduct and administration of the program. These two pilots had completed an Aviation School Methods of Instruction (MOI) course. The principal purpose of that course was to assure their standardized performance in the T-42. In addition, both instructor pilots had taught twin-engine transition and instrument training courses. Similar qualifications, that is, instructor pilot qualification and aircraft standardization, are required of all instructors in addition to their training specifically in the conduct of the new training program.

The instructor training for the new program consisted of two phases. The first phase, which lasted two weeks, was devoted to standardizing instructor performance in the new device, acquainting them with the programed textbooks that the new students would be using, and instructing them in the conduct of the new program. The latter consisted of instruction in behavior control techniques and human learning theory, as well as how to employ MPRs and other course features. Specific attention was directed to the modification of existing concepts of the role of the flight instructor vis-a-vis the student, and the importance of performance criteria rather than experience for training.

The second phase of this instructor training was of eight weeks' duration, a time period which corresponded to the scheduled length of the Army's existing twin-engine transition and instrument training program. During this phase, each flight instructor was assigned two trainees and administered the new program to them under the supervision of the HumRRO research staff. Training in the device and study of assigned academics material occupied the first three weeks of the phase, and training in the aircraft occupied much of the remaining time. All student training by these instructors proceeded in accordance with the description of the new program as presented.

TRAINING PROGRAM EFFECTIVENESS

The new program's initial administration by the two HumRRO-trained instructors conformed very closely to the anticipated hour requirements indicated in Table 1. The actual aircraft, device, and classroom hours required for each trainee to achieve the performance requirements of twin-engine transition and instrument training are indicated in Table 2. The aircraft hour requirement is broken down in Table 2 to indicate the distribution of that time by type of training, that is, IFR (actual instrument and hooded flight), VFR day, and VFR night.

It will be noted that the students tended to require less device time to reach the performance criteria established for that training than had been anticipated. This may be attributed in part to a possible "Hawthorne effect," since the instructors as well as the trainees expressed keen interest in the newness of the device and its far greater apparent training capability than was the case with other training equipment. The extent of such a Hawthorne effect, if in fact it did occur, cannot be determined on the basis of the initial administration of the program. It is believed unlikely, however, that such an effect could invalidate the training concepts underlying the new program.

One trainee required slightly more than the 35 flight hours anticipated in Table 1. That particular trainee was grounded for medical reasons the day before he had been scheduled by his flight instructor to be administered an end-of-course performance checkride. Upon return to flight status, he was given an additional 2 hr period of flight instruction before being rescheduled to take a checkride (Table 2).

It cannot be expected that all students will complete the new course within the indicated 35 hr estimate. It is, after all, a course which is administered on an individual, proficiency-

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*Only two of the new devices had been procured by the Army at the time of the training reported here, and the use of more than two instructors during the initial program administration would have been inconvenient. The training of the two flight instructors was undertaken because of the intent to convey the necessary skills to Army personnel who then would undertake the training of an adequate number of other personnel. This approach is consistent with HumRRO's contract with the Army to engage in training related research and development activities, rather than to undertake directly the admin-[illegible]on of training programs.

Table 2 - Distribution of Training Time

Subject	Device Time*	Aircraft Time IFR/Hood	VFR–Day	VFR–Night	Total	Classroom Time
1	19:00	27:45	5:10	1:00	33:55	39:00
2	19:30	27:55	5:10	1:00	34:05	39:00
3	21:00	27:35	5:55	1:00	34:30	39:00
4	21:00	27:15	6:40	1:15	35:10	39:00

*Time during which the trainee occupied the pilot seat only. This figure does not include the time in which he received training related to copilot functions or observed the training being administered to another student.

based advancement basis, and not all trainees are equally adept at acquiring the necessary skills. It can reasonably be expected that the 35 hr time estimate will be exceeded with the new training program about as frequently as the 60 hr limit of the existing program has been exceeded in the past.

Two checkrides (as well as the diagnostic progress rides described earlier) were administered to each of the trainees by a check pilot from the Standards Section of the Aviation School's Department of Advanced Fixed Wing Training. It was these independently administered checkrides which determined that the trainees had attained the course objectives. The checkrides were identical in content and standards to checkrides administered to trainees in the existing course, and in keeping with established Aviation School requirements, grades were assigned in accordance with The Uniform Flight Grading System (5). The phase flight grades of the students involved ranged 82-86 without the addition of incentive points for early attainment of the course performance requirements. The average phase flight grade for students in the existing course is 83.7. The average was 82.2 for the class from which the four students were obtained.

The relative effectiveness of any new training program which achieves performance objectives identical to an existing program can only be measured by some index of efficiency. The index most appropriate to the present situation is cost. The program which costs less to administer, all factors considered, would have to be judged the more cost effective of the two programs under consideration here. It was beyond the scope of the present research to determine exactly the cost effectiveness of the new training program, although a model for the collection of aviator training cost data is available (6).

A study was made previously of the estimated cost of conducting training in the new device (3). On the basis of those data and data provided by the Aviation School at the time of the present study concerning the cost of flying the T-42, it was determined that an hour of instruction in the new device, using the newly developed training program, cost approximately $40.00 less than an hour of instruction in the aircraft. Thus, a reduction of 25 flight training hours per student, that is, from 60 to 35 hr in the aircraft, would yield a savings in flight training costs of approximately $1000 per trainee. Additional savings would be realized from reductions the lower flight-hour requirement would permit in training support personnel and facilities.

INNOVATIVE PROCESS

Before concluding this paper, a comment is in order on the methodology of innovation. The training program just described includes many changes, and it is not inappropriate to describe it as an innovative program. But how does one go about developing an innovative program?

In the present instance, the process of innovation had three clearly identifiable components. One of these was information in the hands of the innovators. The personnel involved had a thorough understanding of the technology of training. The importance of such an understanding has already been discussed in conjunction with the guiding program design principle of cost effectiveness. In addition, these personnel were thoroughly knowledgeable with respect to the skills to be developed and the criterion behavior required.

The second component was emphasis upon the *product* of training, rather than upon pursuing a particular training *process*. That is, the sole purpose to be achieved by the new program was the production of pilots who could meet the independently established performance criteria. No element of the previous training program (except that the training aircraft was specified) had to be preserved, and no tradition had to be followed. In the present instance, elimination of the requirement to log so many hours per student per flight, the use of a flight instructor in an entirely new role, and the use of incentive awards illustrate the extent of deviation from established training practices, military traditions, and administrative requirements that is possible when emphasis is shifted from an existing training process to the product of training.

Finally, a very important component of the innovative process was the use of personnel outside the training system to develop the new program. Outside experts can take positions and examine approaches prohibited by an existing system. A thorough understanding of the existing system is necessary, of course, but outsiders can more readily overcome the constraints of the system when seeking new approaches. Insiders are more likely to tend to perpetuate existing processes while seeking to improve products.

Not necessarily a part of the innovative process, but perhaps critical to implementation of any new training program, is attention to the manner in which it is introduced.* The practice followed in the present instance was to train thoroughly the personnel involved in the conduct of the new program. Had this not been done, it is unlikely that the same results could have been obtained. Years of experience attempting to change ongoing training activities have shown that new training programs and training equipment will be "adjusted" to fit the constraints of the existing system, unless deliberate effort is made to preserve their unique features, at least until their merits have been demonstrated.

*For other important considerations in the implementation of innovative programs, see Ref. 7.

POSTSCRIPT

During the initial conduct of the training program developed for the new device, the Army terminated input to the existing training program, and further training of undergraduate fixed-wing aviators was suspended upon completion of the training of students then in residence. Consequently, the requirement no longer existed for twin-engine transition and instrument training of undergraduate students. In place of undergraduate fixed-wing training, additional fixed-wing aviators are to be obtained in the Army by providing fixed-wing transition training to previously rotary-wing rated aviators, a practice which had been followed in the past on a smaller scale. At the request of the Aviation School, the new twin-engine transition and instrument training program was modified for use in the surviving program. The modification consisted primarily of taking into account the facts that previously rotary-wing rated trainees are much more experienced than undergraduate trainees and already have rotary-wing instrument ratings. The various features of the new course described in this report were preserved, however.

REFERENCES

1. Wallace W. Prophet and H. Alton Boyd, "Device-Task Fidelity and Transfer of Training: Aircraft Cockpit Procedures Training." Human Resources Research Organization Technical Report 70-10 (1970).

2. Paul W. Caro, "Adaptive Training: An Application to Flight Simulation." Human Factors, Vol. 11 (December 1969), pp. 569-575.

3. Paul W. Caro, Oran B. Jolley, Robert N. Isley, and Robert H. Wright, "Fixed Wing Training Device Requirements of the U. S. Army Aviation School." Human Resources Research Organization Consulting Report (1968).

4. Wallace W. Prophet and Oran B. Jolley, "Evaluation of the Integrated Contact-Instrument Concept for Army Fixed Wing Flight Instruction." Human Resources Research Organization Technical Report 69-26 (1969).

5. "The Uniform Flight Grading System." USAAVNC Reg 350-16 (1970).

6. Oran B. Jolley and Paul W. Caro, "A Determination of Selected Costs of Flight and Synthetic Flight Training." Human Resources Research Organization Technical Report 70-6 (1970).

7. William A. McClelland, "The Process of Effecting Change." Paper 32-68, Human Resources Research Organization, October 1968.